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August 21, 1958

Rec'd 8/22 9:00

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Dear Sir:

Task Order No. C

The purpose of this letter is to review the events of the simulated-field demonstration of the full-scale hydrogen generator that was held on August 5, 1958, and to summarize the results of the meeting that followed this demonstration. Since this was the first full-scale operation of the unit, the demonstration took more time than would be necessary under actual field conditions. The demonstration started at approximately 9:40 a.m. and was completed at 2:40 p.m., with about a one-hour lunch period. We believe that one man could perform the entire operation, including the balloon handling, in approximately 2 hours and 25 minutes if all of the equipment and materials were within 200 feet of the site. Taking the movies, purging the generator, installing the experimental thermocouples, and the operator's inexperience were all factors that increased the time of the simulated-field demonstration.

In order to assist your thinking in regard to future use of the generator, we have outlined for your consideration a possible operating schedule and the possible effect, on this schedule, of the tentative modifications that were mentioned on August 5.

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Possible Operating Schedule

In general, the schedule presented below is in the same sequence as was the full-scale test. Since most of these operations were observed by you and your associates, and since they are shown in the moving pictures, no great detail is given for the operations.

The possible operating schedule is as follows:

(1) Carry the generator, Box A (hand pump, weight bag, and 100-foot rope), and Box B (catalyst, catalyst chart, thermometer, and rubber gloves) approximately 200 feet to the site (in 2 trips). 5 minutes

(2) Inflate the generator airmat section and prepare for entry into the water:

(a) Push in inlet tubes
(b) Attach anchor (rope)
(c) Straighten unit to upright position
(d) Gather rocks. 20 minutes

(3) Finish gathering 15 to 20 pounds of rocks, place the rocks in the weight bag, and tie the bag to the bottom panel of the generator. 10 minutes

(4) Move the generator into the water and begin filling. 5 minutes

(5) Carry 5 packages of sodium borodydride, the balloon, the catalyst container, and related equipment to the site. 15 minutes

(6) Check the generator for air pockets and extent of fill. 3 minutes

(7) Unpack the chemicals; partially fill the catalyst container with water. 5 minutes

(8) Unpack and lay out the balloon on the ground at the shore edge. 10 minutes

(9) Check the generator for air pockets and extent of fill. 3 minutes

(10) Finish the balloon preparations (inlet-tube position, tie down, etc.). 10 minutes

(11) Check the generator for air pockets and extent of fill. 3 minutes

46 mins

(12) If check indicates sufficient fill, pull out the inlet tubes and tie them off; pull the generator near to the shore line. 5 minutes

(13) Pour in the sodium hydroxide and then the sodium borohydride. 10 minutes

(14) Take a temperature reading on the water in the generator; refer to the catalyst chart and mix the catalyst. 6 minutes

(15) Tie the balloon inlet tube to the generator outlet and check the equipment. 5 minutes

(16) Pour in the catalyst solution and tie off the catalyst entry tube; check the generated-gas flow. 5 minutes

(17) Allow hydrogen generation to continue. 25 minutes

On the basis of this schedule, it appears that, if the equipment and materials are far removed from the site, the present generator fill time would not slow down the over-all operation since the second group of equipment and materials (Step 5) could be transported to the site during the fill time. However, if the equipment and materials were at the site, there would be some waiting for the generator to fill with water, unless the addition of the borohydride or the mixing of the catalyst were to be accomplished during the fill time.

Possible Modifications of the Generator

During the meeting following the demonstration, the mechanics of the operation were discussed briefly and ideas were presented for modifications that would reduce the total time required for the operation of the unit. Ideas on modifications were considered for the operation of the generator, the packaging of the chemicals, and the attachment of the balloon. Any modifications on the generator would probably have to be made by the manufacturer, and it appears that these would require a minimum time of six weeks. The principles of packaging the chemicals to reduce the time required to pour the chemicals into the generator can be investigated at our facilities, but, of course, final packaging configurations probably should be decided by a packaging company. On the basis of mutual agreement with [redacted] the balloon attachment and the balloon handling were not a part of the Task Order No. C research program,

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except for the provision on the generator of a 6-inch-diameter outlet with a lip, to facilitate attachment of the balloon inlet tube. However, there is no apparent reason why this work could not be handled at our facilities, if you so desired.

The following summarizes the ideas on modifications of the generator and related equipment that were presented during the meeting on August 5.

Reduction of Generator Fill Time

The investigation of methods to improve the water-filling characteristics of the generator and thus reduce the time required for the filling operation has been relatively limited. We are of the impression that a fill time of 1 hour may not be unreasonable, since there are other activities to occupy the operator's time during the fill period. Nevertheless, modifications as described below may speed up the filling of the generator.

Water Inlet Tube. The two inlet tubes can be replaced with one or more larger openings which would reduce the chances of restricting the spontaneous flow of water into the generator. The ease of opening the water inlet may be improved by this modification, but the tie-off step may be made more difficult. - pump ?

Generator Weights. It is known that the generator fills faster when the downward force on the generator is increased because this force increases water-level differential between the inside

and outside of the unit. The addition of weight can be made by tying weights on the bottom panel of the generator or by placing these weights in pockets which can be provided on the bottom panel. Also, weight can be added to the unit by placing the chemicals, water, rocks, or other types of material on the top of the generator. The effect of weights on the bottom has been investigated, but the effect of weight on the top has not been studied.

Operator's Procedure. The spontaneous filling of the generator may be supplemented by efforts of the operator in pouring water through the gas outlet tube with an auxiliary pail or in directing into the gas outlet tube the water which is trapped on the top of the unit (by manipulating the unit). No attempt has been made to gage the effectiveness of these types of action.

Reduction of Airmat Inflation Time

The time required to inflate the airmat section of the generator can be reduced by using a CO_2 cartridge, which could be provided, or a pump with a larger displacement than the one that is currently being used. In view of the low weight of the unit as compared to the specifications, the provision of a CO_2 cartridge appears to be in order, but a pump should probably also be provided "just in case".

Reduction of Borohydride Addition Time

The addition of the borohydride can be speeded up by the compatible design of the entry port on the generator and the packaging for the material, so as to allow free flow of the material into the generator. Also, the entry port could be made large enough to permit dumping of borohydride from almost any type of package into the generator without restrictions. If the port for the addition of the borohydride were increased considerably in size, it probably would be necessary to provide a separate outlet tube for balloon attachment.

Reduction of Catalyst-Solution Mixing and Entry Time

The time required to mix and to pour in the catalyst solution depends on the ease of measuring the proper amount of catalyst, of mixing the solution, and of pouring the solution into the catalyst ring of the generator. As in the case of the borohydride entry system, the shape and type of package for the catalyst should be closely related to the shape and type of opening on the catalyst-solution mixing container. The size of the catalyst inlet tube to the ring probably should be enlarged, but the entry ring probably could not be modified without further experiments which would determine the effect of the catalyst distribution on the generation time. The present extent of the generator water-fill time would

become less critical if, during this time period, part of the catalyst solution could be prepared.

Safety Measure

There is some question as to the danger of a hydrogen and air explosive mixture in the generator during the initial surge of generated gas. The possibility of a very loose top panel that would collapse over the water fill and eliminate or at least minimize the dead-air space in the generator was discussed. The catalyst entry system and airmat-section support would have to be modified in order to accomplish such a change. The possibility of reducing the overall height of the unit to effectively that of the filled generator was also mentioned. The need for space to accommodate the foam generated during the basic chemical reaction(s), the need for providing for proper distribution of the catalyst solution, and the fact that, if the dead-air space were eliminated, modifications of the airmat section would be required in order to maintain the shape of the unit by support of the stays were considered as deterrents to making such changes.

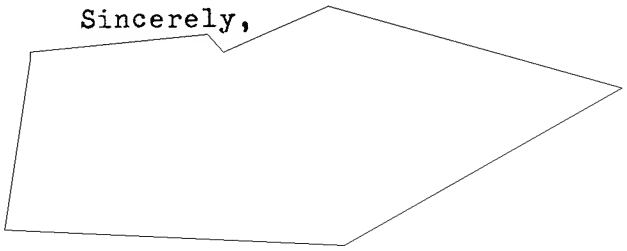
Balloon Adapter

It was obvious from the demonstration that consideration has to be given to the attachment of the balloon inlet tube to the generator. Special adapters and fasteners are needed to permit quick and positive attachment of the balloon inlet tube. The

length of the balloon inlet tube must be kept to a minimum and the water condensate (from the reaction) must be prevented from blocking the flow of hydrogen because the back pressure during a fast generation reaction could possibly burst the generator under these conditions.

If there are any questions about the demonstration or the procedures summarized here, please let us know. We are looking forward to seeing you during the last week in August.

Sincerely,



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